

REMARKS

Applicants acknowledge receipt of the Examiner's Advisory Action dated December 16, 2004. The Advisory Action indicates that Applicants' previous request for reconsideration has been considered but does not place the application in condition for allowance. Accordingly, claims 1-9 stand rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 5,476,816 issued to Mautz et al. ("Mautz") in view of U.S. Patent No. 6,410,417 issued to Tsai et al. ("Tsai"). Applicants respectfully request the Examiner's reconsideration and reexamination of all pending claims since, as shown below, Mautz teaches away from combination with Tsai along the lines set forth in the Final Office Action.

To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success, must both be found in the prior art and not based on Applicants' disclosure. The initial burden is on the Examiner to provide some suggestion of the desirability of doing what the inventor has done. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest that the claimed invention or the Examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references. MPEP 2142.

The prior art reference that “teaches a way” from the claimed invention is a significant factor to be considered in determining obviousness. It is improper to combine references where the references teach away from their combination. *In re Grasselli*, 713 F.2d 731, 743 (Fed. Cir. 1983) (The claimed catalyst which contained both iron and an alkaline metal was not suggested by the combination of a reference which taught the interchangeability of antimony and alkali metal with the same beneficial result, combined with the reference expressly excluding antimony from, and adding iron to, a catalyst). MPEP 2145.

Independent claim 1 recites:

1. A method comprising:
 - forming a tungsten plug in a dielectric layer;
 - forming an electrically conductive interconnect line on the dielectric layer after formation of the tungsten plug, wherein the tungsten plug is electrically connected to the electrically conductive interconnect line;
 - contacting the electrically conductive interconnect line with liquid water after formation of the electrically conductive interconnect line;
 - contacting the electrically conductive interconnect line with *a solution to remove residual polymer* after the electrically conductive interconnect line is contacted with the liquid water;
 - wherein the electrically conductive interconnect line is contacted with the liquid water for less than 120 minutes.

The Examiner asserts that Mautz teaches all the limitations of independent claim 1 except for “contacting the electrically conductive interconnect line with *a solution to remove residual polymer* after the electrically conductive interconnect line is contacted with the liquid water.” The Examiner then asserts that Tsai teaches this missing limitation. More specifically, the Examiner asserts that Tsai teaches photoresist removal by ashing, which often leaves a polymer residue on the surface of the wafer to be subsequently be removed by a wet stripper (i.e., a

solvent, alkaline, etc.) citing column 1, lines 34-60 of Tsai in support thereof. The Examiner asserts that it would have been obvious to one of ordinary skill in the art to have incorporated in the method of Mautz, a solution contacting the electrically connective interconnect line to remove residual polymer, as taught in the method of Tsai.

Applicants assert that it is improper to combine Mautz and Tsai along the lines suggested in the Final Office Action. The abstract of Mautz teaches a middle etching processing sequence which eliminates the need to use an organic masking layer solvent. Mautz makes clear that it is undesirable to use a solvent to remove photoresist. Mautz teaches in column 1, lines 12-62:

Interconnects allow various parts of a semiconductor device to be electrically connected with other parts of the semiconductor device. *Unfortunately, the processes that form interconnects typically introduce mobile ions that degrade device reliability. Mobile ions, such as sodium, lithium, potassium, calcium, and magnesium, typically come from two sources: during a metal etching step and from an organic solvent typically used in removing a photoresist masking layer.* The conventional wisdom of those skilled in the art is that mobile ions introduced during the metal etching steps lie only on exposed surfaces of an insulating layer or an interconnect formed during the metal etching process. A quick deionized water rinse after photoresist removal should remove virtually all of the mobile ions if they lie on exposed surfaces. Semiconductor devices that only have a deionized water rinse after photoresist removal still have unacceptably high device reliability problems.

Organic masking layer solvents include mobile ions. As used in this specification, an organic masking layer solvent is a chemical that is capable of readily removing an organic masking layer (i.e., photoresist, etc.). Examples of organic masking layer solvents include ketones (2-propanone) (acetone), etc.) aliphatic hydrocarbons (n-heptane, etc.) alkali-amines (tetramethyl ammonium hydroxide, etc.), and aryl hydrocarbons (toluene, phenol, etc.). Examples of chemicals that are not organic masking layer solvents include alcohols

(methanol, ethanol, 2-propanol (isopropyl alcohol), or the like) and glycols (methanediol (methylene glycol), 1,2-ethanediol (ethylene glycol), 1,2-propanediol (propylene glycol), or the like). These latter chemicals typically have at least one hydroxyl group for no more than ten carbon atoms within the molecule, wherein that hydroxyl group is directly attached to a carbon atom other than a carbon atom that is part of an aryl radical (i.e., not phenol). Although the alcohols and/or glycols may attack an organic masking layer, the rate of removing the organic masking layer typically is slow enough that it does not make the alcohols and/or glycols a chemical that readily removes an organic masking layer.

Many photoresist removal processes after a metal etching step use an organic masking layer solvent by itself or an aggregation of plasma ashing and an organic masking layer solvent. Many commercially-available organic solvents have mobile ions concentrations that are measured in parts per million. High-purity solvents are available that have mobile ions concentrations as low as about 10 parts per billion. However, these high purity organic solutions may still add mobile ion contamination to semiconductor devices. The cost of the organic solvents increase dramatically with higher purity.

Mautz then teaches in column 5, lines 23-29:

After the plasma metal etching step, the photoresist members 421 and 422 may be removed using at least one conventional plasma ashing technique. The photoresist members 421 and 422 are substantially removed by the plasma ashing step. *The photoresist member 421 and 422 are not removed in whole or in part by organic masking layer solvents.*

Even though Tsai may teach removing residual polymer on the surface of the wafer using a wet stripper (i.e., a solvent, alkaline, etc.) in column 1, lines 34-60 as noted by the Examiner, Mautz teaches that the wet stripper (solvent) should not be used in his process.

Clearly, Mautz teaches away from using the solvent of Tsai in his process to remove photoresist because of the introduction of mobile ion contamination and other reasons.

Accordingly, Mautz should not be combined with Tsai along the lines suggested by the Final Office Action to render claims 1-9 unpatentable under 35 U.S.C. § 103.

CONCLUSION

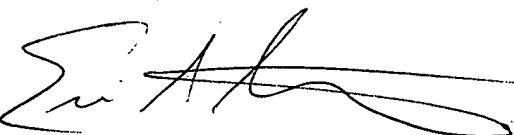
Applicants submit that all claims are now in condition for allowance, and an early notice to that effect is earnestly solicited. Nonetheless, should any issues remain that might be subject to resolution through a telephonic interview, the Examiner is requested to telephone the undersigned.

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Mail Stop AF, Commissioner for Patents, P. O. Box 1450, Alexandria, Virginia, 22313-1450, on 1/12/05.


Attorney for Applicant(s)

1/12/05
Date of Signature

Respectfully submitted,



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